

Deuteron photodisintegration by linearly polarized photons

Abstract

We propose to measure the asymmetry of the $\gamma d \rightarrow pn$ cross section in the photon energy range $E_\gamma = 0.6 \rightarrow 2.4$ GeV. The measurements will be carried out with a linearly polarized photon beam, which is obtained by coherent bremsstrahlung of relativistic electrons in a diamond crystal. These measurements will allow one :

- to check the predictions of the available theoretical models of the $\gamma d \rightarrow pn$ process in the energy range of $1 \rightarrow 2$ GeV;
- to clarify whether quark mechanisms or hadron mechanisms determine $\gamma d \rightarrow pn$ in this energy range;
- to determine the possible addition of nonnucleon (N^*) configurations in the deuteron wave function and their characteristics;
- to check, using new experimental data, the phenomenon of asymptotic scaling in $\gamma d \rightarrow pn$ predicted in [3 - 6] and observed in SLAC experiments [1, 2].

The experiment will be a part of the program for studying $\gamma d \rightarrow pn$ proposed for CEBAF [7, 8].

Introduction

For more than fifty years deuteron photodisintegration

$$\gamma d \rightarrow pn \tag{1}$$

has attracted great deal of attention, since it is the simplest nuclear process whose studying allows one to check fundamental ideas of nuclear and elementary particle physics.

At the present time the photon energy range $E_\gamma \geq 1$ GeV is the most interesting for studying. In this range the reaction mechanisms are complicated and, apparently, substantially evolve with increasing energy. Recent measurements performed at SLAC [1, 2] show that at energies $E_\gamma \geq 1.4$ GeV mechanisms of the reaction caused by quark configurations are possible. At the same time according to theoretical computations [9] the data of ref. [1, 2] can be satisfactorily described within the framework of the meson - nucleon theory up to the energy $E_\gamma \approx 2$ GeV. At higher energy ($E_\gamma \approx 2.4$ GeV) a change in the reaction mechanism is possible, and the description of the process using QCD may be more adequate.

One should expect that qualitatively new information on the process (1) in the range of energy higher than 1 GeV can be obtained by studying polarized observables which are often more sensitive to the details of the mechanism than cross sections. In particular, it is important to study the asymmetry of the reaction (1) cross section:

$$\Sigma = \frac{d\sigma_{\parallel} - d\sigma_{\perp}}{d\sigma_{\parallel} + d\sigma_{\perp}} \tag{2}$$

where $d\sigma_{\parallel(\perp)} = d\sigma_{\parallel(\perp)}/d\Omega$ is the cross section in the case when the photon polarization vector is parallel (perpendicular) to the reaction plane. First, according to [9], the model of ref. [3 - 6] and the meson theory give qualitatively different predictions. Second,